Does trade policy impact food and agriculture global value chain participation of Sub-Saharan African countries?

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Does trade policy impact food and agriculture global value chain participation of Sub-Saharan African countries?

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Abstract

The emergence of food and agriculture global value chains (GVCs) is challenging the way scholars look at trade data and policy makers conduct their trade policies. The common perception is that Sub-Saharan African (SSA) countries, unlike most Latin American and Asian countries, are not deeply integrated into global production networks. Consequently, it is believed that their border protection policies may have a limited impact on GVC participation. This paper challenges this conventional knowledge in two ways. First, by decomposing bilateral gross export into its value added components, it shows that the sectoral and bilateral SSA participation in GVC for food and agriculture is substantial. Second, it demonstrates that trade policies impact backward and forward value chain linkages. These results call for a refinement of trade policy priorities in SSA.

Keywords: Global value chains, agriculture, food, trade policy, gravity model, Sub-Saharan Africa.

JEL codes: F14, L23, O11, O55, Q17.

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Since the last decades of the 20th century, food and agriculture global value chains (GVCs) keep growing as products cross borders multiple times and the international production networks, dominated by modern food processors and retailers, become more vertically organized (Reardon et al, 2003; Minten et al., 2009; Greenville et al., 2017).[i] Meanwhile, agro-food trade has more than quadrupled in nominal terms during the past three decades, from USD 230 billion in 1980 to almost USD 1,100 billion in 2010; a dramatic increase driven by several factors including GVC growth. Indeed half of this total agro-food trade can be considered of intermediate usage for global production processes (Maertens and Swinnen, 2015; OECD, 2016).[ii] These developments are challenging the way agriculture and food trade data are used and interpreted because conventional statistics have become increasingly misleading as a measure of the value produced by any particular country (Koopman et al., 2014). For instance, using gross trade statistics, the final producer may appear to generate most of the value of goods, while the role of countries providing inputs upstream – such as countries in Sub-Saharan Africa (SSA) – could be largely underestimated.

However, while the literature on GVCs has been abundant (e.g. Gereffi et al. 2005; Giuliani et al., 2008; Costinot et al., 2013; Del Prete and Rungi, 2017), the effects of trade policies on the emergence of GVCs have only been theoretically and empirically analyzed relatively recently (Antràs and Staiger, 2012; Blanchard and Matschke, 2015; Gawande et al., 2015). At the same time, the specter of protectionism is at its strongest since the late '80s as value chain concerns figure prominently in international trade debates related to the North American Free Trade Agreement (NAFTA), the Trans-Pacific Partnership (TPP), and the African Continental Free Trade Area (AfCFTA).

This analysis applied to the agricultural and food sectors of SSA countries is of primary importance for policy making and trade negotiations. Firstly, because protection levels in these two sectors are still the highest in the world (see Figure 1A in the Appendix). Secondly, the agriculture sector in these countries still generates about 25% of the gross domestic product (GDP), or 50% if we look at the broader agribusiness sector, and involves roughly 65% of the local population, mostly in family farming activities (Alliance for a Green revolution in Africa -AGRA, 2016). The common perception is that SSA countries, unlike most Latin American and Asian countries (Gereffi, 1996, 1999; Montalbano et al., 2016, 2018; Baldwin and Lopez-Gonzalez, 2015) are not deeply integrated into global production networks and consequently their border protection policies may have a limited impact on GVC participation. This paper challenges this conventional knowledge in two ways. First, we measure the participation of SSA countries in the agriculture and food GVCs, i.e. we unpack the different stages of the production process to identify the contribution of each country to trade flows in terms of value added content. To this aim, we apply for the first time in the case of SSA the bilateral gross exports decomposition method developed by Wang et al. (2013) (Wang, Wei, and Zhu, hereinafter WWZ) to the EORA multi-region input-output tables (MRIO). These tables provide a contiguous, continuous dataset for the period 1990-2013 for 186 countries - of which 43 are from SSA (Lenzen et al., 2012; 2013) (see Section 2 and Supplementary Appendix online for additional details).

Second, we rely on a structural gravity model to study whether and how bilateral import tariffs as well as shifts in trade regimes associated with regional trade agreements (RTAs) affect the agriculture and food GVC participation. More specifically, we examine the SSA countries' backward participation (i.e., the use of foreign inputs for exports) and forward participation (i.e., the use of domestic intermediates in third country exports).

Our findings are in line with the most recent literature which suggests that Africa is more integrated into GVCs than many other developing regions (Foster-McGregor et al., 2015). It also highlights that global linkages have been increasing over time. Much of Africa's involvement into GVCs is however in upstream production activities, i.e. specializing in providing primary inputs to firms in countries further down the chain (Del Prete et al., 2017). Finally, our empirical analysis shows that bilateral trade policies are key determinants of both backward and forward GVC participation in the food sector and, to a lesser extent, in the agricultural sector. These results are consistent for the aggregate case - where we use the entire global dataset - and for the subset of SSA countries. Therefore, trade policies appear to have an important "chain effect" suggesting that a restriction imposed by one country not only dampens partner countries' exports but also the country itself through value chain linkages. This confirms the theoretical argument whereby optimal tariff policy no longer exclusively depends on the location of the imported good, but also on the nationality of the value added content embodied in that good (Blanchard et al., 2016).

The remainder of the article is organized as follows: Section 2 presents the methodology for decomposing gross trade in value added terms and a comprehensive map of agro-food GVC participation in SSA and relative trade partners. Section 3 describes the identification and the empirical strategy. Section 4 presents the outcomes of the empirical analysis and some robustness checks. Finally, Section 5 concludes and suggests policy implications.

Decomposing gross trade in value added terms: methodology and data

In this work, we calculate the value added embedded in gross exports using the methodology developed by WWZ, as it generalizes the accounting framework proposed by Koopman et al. (2014) from a country-level perspective to one that decomposes gross trade flows at the sector, bilateral, or bilateral-sector level (see Supplementary Appendix online for additional details). It also allows us to identify and account for the "pure double counting" term (PDC) that arises when intermediate goods cross borders back and forth multiple times.[iii]

Thus, we exploit five key components of value added exports:

i) the *direct domestic value added* (*dirDVA*), that is, the domestic value added in intermediates and final goods exports absorbed and consumed by direct importers. Since it is the result of a single exchange of goods it does not enter into the computation of GVC participation and, consequently, in our empirical exercise we use it as a proxy for gross exports;

ii) the *indirect domestic value added* (*DVX*), that is, the domestic value added in intermediate goods further re-exported by the partner country. It measures the joint participation of the bilateral trade partners in a GVC since it contains the exporter's value added of a specific sector that passes through the direct importer for a (or some) stage(s) of production before it reaches third countries (or eventually returns home[iv]). More specifically, it captures the contribution of the domestic sector to the exports of other countries and indicates the extent of involvement in GVC for relatively upstream industries. In our empirical analysis, we use this component as a measure of *forward* GVC participation;

iii) the *foreign value added* (*FVA*) used in the production of a country's exports, which consists of the value added contained in intermediate inputs imported from abroad, exported in the form of final or intermediate goods. We use this component as a measure of *backward* GVC participation.

Finally, to isolate the bilateral relationship of the trade flow which involves only partner and reporter countries, we identify two further sub-components:

iv) the *MVA*, that is the share of the foreign value added that comes exclusively from the direct importing country;

v) the *dirRDV*, that is the share of indirect valued added that ultimately returns home exclusively via the partner country.

Data used in this work come from the EORA - MRIO database, which provides a contiguous, continuous dataset for the period 1990-2013 (Lenzen et al., 2012; 2013). EORA contains data for 186 countries - of which 43 are in SSA - and 25 harmonized ISIC-type sectors.[v] In this study, we focus on the agriculture (ISIC codes 1, 2) and food and beverages (ISIC codes 15, 16) sectors (see Supplementary Appendix online for additional information).

Mapping food and agriculture GVCs

Thanks to the use of the EORA dataset we are able to disentangle the domestic and foreign contribution in value added of bilateral exports. Therefore, we can get a comprehensive picture of agriculture and food GVC participation for a single country across all partners in each sector.[vi] To this end, we sum up the *DVX*, the *FVA* and the *PDC* components to provide an overall *GVC participation index* (Koopman et al., 2011; Rahman and Zhao, 2013). The higher (or lower) the value of the GVC participation index, the larger (or smaller) the participation of a country in GVC. The maximum value of GVC index is 1, in the extreme case where gross exports are entirely determined by GVC related activities.

Figure 1a shows the aggregate GVC participation index in 2013 across all sectors and by regions, distinguishing the three components: *DVX*, *FVA*, and *PDC*. As a preliminary remark, we can note that the EU27 and ASEAN countries are the most integrated.[vii] Nevertheless, the SSA participation rate is surprisingly high (40%), matching the level found for China and India. This means that almost half of all trade activities in SSA are GVC related. This finding is in line with the literature applying other decomposition methods (see, among others, African Development Bank, 2015; Foster-McGregor et al., 2015; Kowalski et al., 2015).

Looking at the different components of the GVC participation, Africa (especially North Africa, denoted NA) emerges as the best performer in providing value added to other countries to be further re-exported (*DVX*). About 25% of the domestic value added produced in SSA are inputs for other countries' exports (over 35% in the case of NA). These figures can be compared with those of the Middle East (25%). They are higher than those of the EU27, China, and NAFTA that register rates of around 20% (see the *DVX* component in Figure 1a). Note that relative to other methods, the WWZ methodology allows us to properly isolate the pure double counted term (i.e., *PDC* in the figure) which appears to be substantial (e.g., 12% for the EU; 4% for SSA).

Figure 1b shows the emergence of the international fragmentation of production over the last two decades. Although GVC participation is increasing worldwide, China experienced the largest increase after its WTO accession (that took place in 2001), whereas the SSA participation went up to 40% in 2013, from a value of 37% in 1995.

Figure 2 and 3 report the sectoral contributions of agriculture and food using the measures of GVC participation described above.[viii] Figure 2 shows that the agricultural sector in SSA is the most involved in GVCs if compared to other regions of the world (Figure 2a) and its participation is increasing over time (Figure 2b). About 3% out of 40% of total GVC participation stems from the agriculture sector, i.e. a contribution equal to 7% across all 25 EORA sectors. For instance, the same figure for the EU27 is only 2%. Furthermore, the sector presents a relatively higher domestic value added components used by other countries' exports (*DVX*) with respect to foreign value added components (*FVA*), confirming its upstream position along the chain where it acts as a supplier of intermediate inputs.

For the food sector (Figure 3), the EU27 and Latin American countries present the highest participation rates (Figure 3a). We find that 4% (1.7% out of 40%) of the total GVC participation in SSA is due to food activities and this share is relatively stable over time (Figure 3b). Unlike the agricultural sector, the position of SSA lies closer to the final consumers (i.e., downstream position) as shown by the more balanced ratio between the *DVX* and *FVA* components.

To sum up, SSA takes part in GVCs by contributing mainly to the upstream phases, being confined to low value added stages of production, but with differences in value added content between agriculture and food exports.

However, these overall figures hide a substantial degree of heterogeneity within the region. To shed more light on this, in Table 1A (Appendix A), we report the same GVC components for the 43 SSA countries present in our dataset, together with the sectoral contribution of agriculture and food in 2013. Some SSA countries, such as DR Congo, Ethiopia, Lesotho and Guinea, register relatively high involvement in the international fragmentation of production compared with the other countries in the region. This is most probably due to the bias of their production structure towards the export of natural resources (DR Congo) or the small size of their economy (Lesotho). Others, such as Benin, Chad and Mali, seem to be more excluded from the global market, likely because of geographical remoteness and/or lack of resources. Note also that in almost all SSA countries, GVC participation mainly consists in supplying inputs to other countries' exports (*DVX*), whereas only a few of them participate primarily as buyers of foreign inputs for their exports (*FVA*). In the latter group, Ethiopia is a peculiar case. It is among the most integrated countries in GVCs exhibiting one of the highest levels of contribution of the agricultural sector to the total GVC participation in the region (31%). Other SSA countries where the contribution of the agricultural sector to the total GVC participation is quite remarkable, i.e. above 30%, include Côte d'Ivoire (33%), Ghana (34%), Kenya (30%), Madagascar (38%), Malawi (39%) and Uganda (32%). Finally, the last column of Table 1A clearly shows that the contribution of the food sector to the countries' GVC participation is, on average, lower than what is observed for the agricultural sector with rates usually below 10%. The only countries registering noteworthy performances are Côte d'Ivoire (15%), Kenya (15%), Mauritania (21%), Namibia (28%), Senegal (42%), and Swaziland (16%).

As mentioned above, the WWZ (2013) decomposition method also allows us to disentangle the value added components of the bilateral gross trade flows. In section 3 of the Supplementary Appendix online, we report the value added components (*DVX* and *FVA*) of SSA exports by groups of partner countries across the main destination regions (in percentages), namely Europe, NAFTA, LAC, Africa, South and East Asia in both agriculture and food sectors. Not surprisingly, most likely due to the colonial legacy, [ix] the European countries (EU27) are the main importers of value added exports from the SSA countries for both sectors. While the percentage of *FVA* absorbed by EU27 is around or below 50%, the percentage of *DVX* is 68% for agriculture and 62% for food.[x] The very high share of the *DVX* component of SSA countries to the EU27 suggests that the agricultural and food products of SSA are first exported to the main European hubs such as Netherlands[xi], Germany and the UK and, once processed, further re-exported to third countries. At the same time, the relatively low percentage of *FVA* absorbed by the EU27 may be associated with the fact that for the SSA producers, it appears difficult to have direct access to the European market because of issues related to consumers' preferences as well as public and private safety and quality standards (Lee et al., 2010).

Identification and empirical strategy

The remaining part of this paper analyzes whether and how protective measures at the border affect participation in GVCs. In this respect, the most recent literature underlines two potential effects of bilateral tariffs: i) a "magnification effect", whereby goods that cross national borders multiple times incur multiple tariff costs. As such, tariffs are applied to gross imports, even though the value added content may be only a fraction of this amount. Different ways of international involvement, notably upstream or downstream participation, shape the extent to which countries are affected by this cost magnification (Yi, 2003; 2010; Muradov, 2017); ii) a "chain effect" which influences all the stages of a GVC and, consequently, a country's backward and forward participation. In terms of forward participation, a depressing impact is expected on the domestic value added content of a country embodied in partner countries' exports. This is because, by reducing the gains for foreign producers of final goods, tariffs also hurt their upstream domestic suppliers. In terms of backward participation, when import-competing sectors use foreign inputs, tariffs allow to pass some protectionist rents from the domestic producers on to upstream foreign input suppliers. This could represent an incentive for foreign suppliers to move to those countries/sectors to get the benefits of the protection (Blanchard et al., 2016). Moreover, while the majority of observed protective measures are bilateral, some of them are the result of free trade agreements or customs unions which can affect GVC participation differently, entailing a broader notion of preferential trade regimes, including rules of origins and possible non-tariff issues (Curran and Nadvi, 2015).

This analysis is of primary importance in policy making and negotiations in the agricultural and food sectors of SSA countries, since the protection levels that countries confer to these two sectors is the highest in the world (Bown, 2015; Caliendo et al., 2016). As Figure 1A in the Appendix shows, the average level of tariff rates is still above 10% for agriculture (Figure 1Aa) and well above 15% for food (Figure 1Ab). Also, while the number of signed RTAs is increasing worldwide, SSA countries are less involved in trade agreements, with about 20 trade agreements signed by each SSA country on average, well below the level of OECD economies (see Figure 2A in Appendix).

To assess empirically the relation between trade policy and GVC participation, we rely on the well-established gravity model which has been used as a workhorse for analyzing the determinants of trade flows for over fifty years (Tinbergen, 1962; Anderson, 1979; Bergstrand, 1989; Deardorff, 1998; Eaton and Kortum, 2002; Chaney, 2018). While the original gravity equation made use of countries' size, bilateral distance, and a set of dummy variables such as common languages, colonial ties and common land borders, to explain bilateral flows, different specifications of the structural form of the gravity equation have recently emerged. These revised empirical specifications of the gravity model rely on country-time and country-pair fixed effects (Baldwin and Taglioni, 2006; De Benedictis and Taglioni, 2011; Head and Mayer, 2014; Baier and Bergstrand, 2007; Piermartini and Yotov, 2016): country-time fixed effects control for time-varying factors that could influence trade and account for the 'multilateral resistance' terms (Anderson and Van Wincoop, 2003);[xii] country-pair fixed effects account for endogeneity bias between bilateral protection and trade flows.[xiii] We apply this revised specification in order to provide a more grounded theoretical underpinnings and a more parsimonious econometric specification. We thus identify the effects of trade policy without quantifying separately the effects of the other time-varying gravity determinants - such as economic size - and bilateral time-invariant characteristics - such as geographical distance and common language. In this setting, these gravity determinants are still controlled for but absorbed by country-time fixed effects (in the case of time-varying determinants) and pairs fixed effects (in the case of bilateral time-invariant characteristics). The use of a full set of country-time and pair fixed effects also absorbs all variations in multilateral MFN tariffs in our data.

We identify the effect of bilateral trade policies on the participation of SSA countries in the food and agricultural GVCs using the following equation:

$$GVC_{ijt} = \alpha_0 + \alpha_1 \text{tariff}_{jit} + \alpha_2 \text{rta}_{jit} + \theta_{it} + \gamma_{jt} + \phi_{ij} + \varepsilon_{ijt} \quad (1)$$

where *i* identifies the reporter country, *j* the partner country, and *t* denotes time. *GVC* stands for selected bilateral components of exports in value added as outlined in Section 2. More specifically, we first use as dependent variables the *dirDVA*, *DVX* and *FVA* components separately. The variable *dirDVA* provides a baseline estimate to proxy the impact of bilateral trade policies on gross exports, in that it captures the part of value added that does not enter into the GVCs (i.e., it does not entail any international production fragmentation). *DVX* and *FVA* are used as measures of forward and backward GVC participation, respectively, since they capture the share of value added flows belonging to a production process globally fragmented.

Then, we proxy bilateral protection by using the applied tariff rate in agriculture (food) of the partner country *j* to the reporter *i* ($tariff_{jit}$)[xiv] and a dummy variable for the mutual participation to the same trade agreement (rta_{jit}).[xv] The expected sign of α_1 is negative, which would imply that the tariff faced by country *i* is not only hampering its capacity to exchange goods for final consumption in *j* (*DirDVA*), as in the standard framework, but also its backward and forward participation (*FVA* and *DVX*) because of the concurrence of both the magnification and the chain effects illustrated above. The expected sign of α_2 is instead ambigous. On the one hand, we may find a positive impact, since RTAs are meant to introduce a broader set of bilateral preferences between members and include possible non-tariff issues such as general regulatory policies (Baier and Bergstrand, 2007). On the other hand, this positive impact could be, totally or partially, offset by strict rules of origins (i.e., request for additional domestic stages of production by the importing country), prolonged phase-in periods, as well as a high influence of multilateral inputs on foreign value added that do not directly benefit from bilateral preferences (Curran and Nadvi, 2015; Blanchard et al., 2016).

Finally θ_{it}, γ_{jt} and ϕ_{ij} represent the above-mentioned reporter-time, partner-time and country-pair fixed effects, respectively, while ε_{ijt} is the error term. Standard errors are clustered by country-pair to control for dyadic error correlation, as the use of country-pair fixed effects is supposed to not fully account for this further source of bias. This is because trade flows between *i* and *j* are serially correlated with all the other country pairs that include also *i* or *j* (Cameron and Miller, 2015). All the continous variables in eq. 1 are in natural logs including the value added components of bilateral exports which are reported in monetary values (thousands of US dollars) and not as exports' shares as in the descriptive analysis (section 2). In such a log-log setting, the estimated coefficients can be interpreted as elasticities.

However, we acknowledge that the gravity approach needs improvements to take on board the key features of value added trade, such as the fact that bilateral value added flows do not depend only on bilateral trade costs but also on costs with third countries through which value added transits from source to destination. As Johnson and Noguera (2012) show, the relative importance of these additional effects varies significantly across countries and types of trade costs. Also, Baldwin and Taglioni (2014) underline that when trade in parts and components is relevant, GDPs in both the exporting and importing countries are poor proxies for supply and demand. Therefore, to soften the additional bias due to value added trade, we re-estimate eq. 1 using only the direct bilateral chain relationships between the reporter and the partner (eq. 2). To do this, we use as dependent variables the amount of domestic value added re-exported that ultimately returns home via the partner country (*dirRDV*), and the foreign value added that comes from the direct importing country (*MVA*). In this case, the gravity equation takes the following form:

$$(2) \qquad DirGVC_{ijt} = \beta_0 + \beta_1 \text{tariff}_{jit} + \beta_2 \text{tariff}_{ijt} + \beta_3 \text{rta}_{jit} + \vartheta_{it} + \tau_{jt} + \psi_{ij} + \epsilon_{ijt}$$

where $DirGVC_{ijt}$ is alternatively *dirRDV* and *MVA* and, as above, $tariff_{jit}$ and rta_{jit} are the applied tariff rate in agriculture (food) of the partner country *j* to the reporter *i* and the dummy variable signalling the mutual participation to the same trade agreement. However, differently from the previous specification, here we also control for the effect of a country's restrictive measure on its own GVC participation ($tariff_{ijt}$), that is the applied tariff rate of the reporter *i* to partner *j*. Such a link is virtually non-existent except in the case of vertically fragmented production processes whereby some of the domestic value added exported may be embodied in imports from the direct partner country (*dirRDV*) or the foreign value added embodied in exports may come from the direct importing country (*MVA*). In the first case, we expect a negative sign on β_2. In the second case, the effect is more ambiguous, as the negative impact of the import taxation on the foreign value added sourced from the partner country may be counterbalanced by the development of import-competing sectors. This may eventually raise the incentive of the direct importer to increase its input supply by taking advantage of the protectionist rents (Blanchard et al., 2016). Finally ϑ_{it}, τ_{jt} and ψ_{ij} represent the usual set of reporter-time, partner-time and country-pair fixed effects, respectively, while ϵ_{ijt} is the error term.

Table 2A in Appendix reports the variables applied in the empirical analysis and the related main descriptive statistics.

Empirical analysis

Tables 1 and 2 report the estimates for eq. 1 and 2 over the period 1990-2013 both for the entire sample of 186 countries included in the EORA dataset and for the sub-sample of 43 SSA countries, respectively.

The first five columns (from 1a to 5a) report the coefficients for the agricultural sector, whereas the second set of five columns (from 1b to 5b) report the same estimates for the food sector.

As expected, Table 1 shows that the average bilateral tariff faced by the reporters' exports ($tariff_{ji}$) is negatively correlated with the direct domestic value added of the reporting countries' exports (*dirDVA*). This is true for both the agriculture and food sector (columns 1a and 1b). If we bear in mind that *dirDVA* is the value added component that best proxies gross exports, the above estimated coefficients reflect the general negative impact of bilateral protection on agriculture and food trade flows. More interestingly, the table further shows the negative and statistically significant impact of the partner country border protection on the reporter country's forward (*DVX*) and backward (*FVA*) GVC participation in agriculture (columns 2a and 3a) and food (columns 2b and 3b). These results show that bilateral trade protection is not only hampering the single exchange of goods between two countries, it is also undermining the capacity of a country to participate in longer value chains characterized by multiple exchanges of intermediates and final goods.

Columns 4a and 5a, and columns 4b and 5b report the results of eq. 2 on the direct bilateral chain relationships between the reporter and the partner. The coefficients on $tariff_{ji}$ are still significant and similar in magnitude to those of *DVX* and *FVA* variables, confirming the goodness of fit of our estimates. The estimated coefficients associated with the bilateral tariffs applied by the reporter country to its partners ($tariff_{ij}$, second row Table 1) show a negative effect on the direct forward participation (*dirRDV*, columns 4a and 4b) and the direct backward participation (*MVA*, columns 5a and 5b). However, these effects are statistically significant only for the food sector. All in all, this result indicates that where international fragmentation of production prevails, a country's GVCs performance does not only depend on the level of protection it faces from other countries, but also on its own level of import taxation in the same sector. There is a main policy recommendation to be derived from this finding on the so called chain effect of tariffs. If a country increases its import taxation with the aim to support the development of the domestic sector for example, this same country should expect to pay a cost in terms of involvement into GVCs.

Finally, the third row in Table 1 shows the effects of the existing preferential trade regimes (*RTAs*). The coefficients indicate a positive and significant impact of the *RTAs* on almost all the components in the food case (columns from 1b to 4b), except for the direct bilateral backward participation (*MVA*). This confirms the positive effect of the vertical integration between partners and downsizes the potential trade diversion effect of the RTA on the GVC participation for this sector. Trade agreements are key, as they can determine meaningful shifts in trade regime – also in terms of rules of origins - with pervasive effects on GVC participation of source countries apart from pure variations in applied tariffs. However, a different picture emerges if we look at the impact of RTA on the agricultural GVC participation (columns from 1a to 5a), where trade agreements are no longer statistically significant (except for *dirRDV*).

Table 2 reports the same analysis for the sub-sample of SSA countries. Results appear in line with those of Table 1. As can be seen in the first row of Table 2, the average bilateral tariff applied by the partner countries to the reporters' exports ($tariff_{ji}$) is negatively correlated with all the components of trade in value added, but it is significant only for the food sector. In the second row of the same table – referring to the tariffs applied by the reporter country to its partners ($tariff_{ij}$) – the coefficient on dirRDV in the food sector (column 4b) is the only one significantly correlated with the dependent variable. Yet, it is relevant because it highlights the importance of the chain effect of tariffs also in SSA economies. Finally, looking at the third row, we see that the estimated impacts of RTAs on forward GVC participation are positive although only marginally statistically significant in agriculture. By contrast, these estimated impacts are weakly significant and negative in the food sector. This latter result highlights the likely trade diversion effects of strict bilateral regulations associated with RTAs.

To conclude, in line with the theoretical arguments, our results point to: i) a depressing role of the importer's tariffs on all components of value added exports; ii) a negative effect of the exporter own import tariffs on the domestic value added that returns home (a chain effect) in the food sector, both at the global level and for SSA. However, the effect on the foreign value added sourced from the partner country appears ambiguous, and iii) a consistently positive effect of regional trade agreements on forward GVC participation in the food sector at the global level. However, this latter result is not confirmed in the case of SSA countries. These trade diversion effects do not seem to emerge in agriculture where we consistently find a significant and positive relation of RTAs on the direct forward GVC participation both at the global level and for SSA countries.

We further test whether our previous findings on the effects of bilateral trade policies on backward and forward GVC participation are robust to different empirical checks. We first verify whether discernable differences can be registered running the same estimates by using weighted measures of tariffs instead of the simple ones. On the one side, these measures can adequately take into account the strong heterogeneity of tariffs characterized by different elasticity of demand. On the other, since weights are built using import flows, these measures may cause additional sources of endogeneity. To soften this issue, we apply one year lagged weighted tariffs.[xvi] In Table 3 and Table 4 we report the results. The main findings are still valid, i.e. tariffs faced by partner countries are likely to discourage GVC participation. Specifically, both at the global level and for SSA countries, the estimated coefficients associated with the bilateral tariffs applied by the partner countries ($tariff_{ji}$) – in agriculture and food – are significantly and negatively correlated with the levels of bilateral value added flows. The "chain effect" of trade policy is confirmed at the global level, also for the direct forward GVC participation (dirRDV) in agriculture. In the case of Sub-Saharan Africa, a significant and negative effect is again found but only for direct forward GVC participation (second row, column 4b, Table 4) in the food sector. Also the pattern of RTAs coefficients are confirmed and are found to be positively associated with value added trade in the food sector (at the global level) and with direct forward GVC participation in agriculture.[xvii]

Conclusions

This study closely analyzes the international fragmentation of food and agricultural production processes and its relationship with trade policy. By exploiting the EORA database and applying the gross exports decomposition method provided by WWZ to these data, we show that despite low gross trade shares at the global level, SSA countries are deeply involved in GVCs and often more than many other developing regions. Moreover, their GVC participation is still limited to upstream production stages, i.e. the region is relatively specialized in providing primary inputs to countries closer to the final consumers.

Second, our empirical results highlight the relevance and significance of tariffs and RTAs in explaining the heterogeneity of GVC participation. We find that the level of tariff faced by countries is not only hampering their capacity to exchange goods for final consumption, as in the standard framework, but also their backward and forward GVC participation. Furthermore, we also find evidence of a ‘chain effect’ of the exporter own import tariffs, i.e. border protection measures may depress the domestic value added used by trading partners that ultimately returns home. This has possibly important policy implications, since trade policies no longer exclusively depend on the location of the imported goods, rather on the nationality of the value added content embodied in traded goods. Consequently, there may be a need to reformulate trade policy priorities, especially in the food sector.

While we believe these results provide scholars and policymakers with a useful framework for testing the importance of policy measures on bilateral GVC relationships, we also acknowledge that more should be done both in the development of new and improved data, such as more disaggregated MRIO tables, and in the analysis of the entire set of protectionist measures, as nowadays tariffs represent only a fraction of the overall trade costs. Because it was beyond the scope of this paper, future research on GVCs in SSA or other regions could investigate the relative importance of factors that could influence increased participation into GVCs including, for example, better infrastructures, improved logistics, guaranteed property rights and enforced contracts, as well as more complete financial and credit markets. Methodologically, it could also be interesting to analyse the short and long run effects of change in tariffs as well as the value of some numerical tariff multiplier due to the chain effect.

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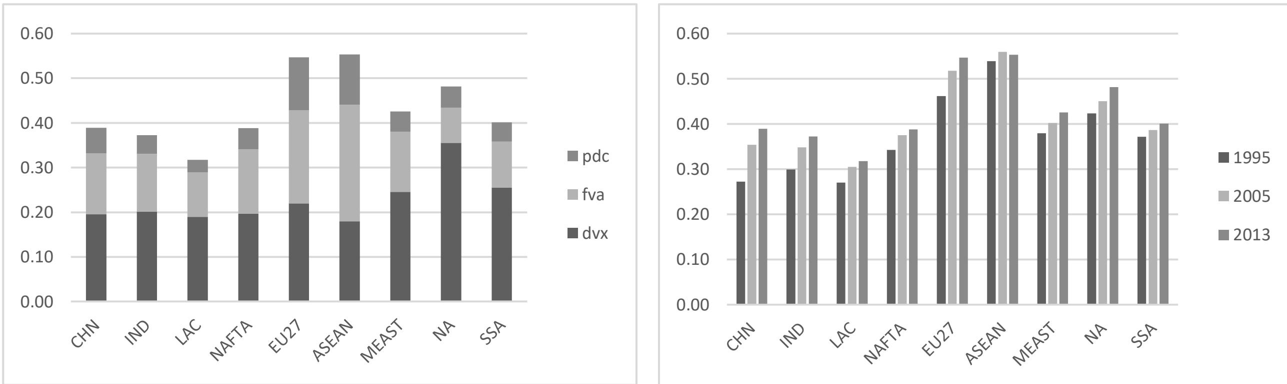
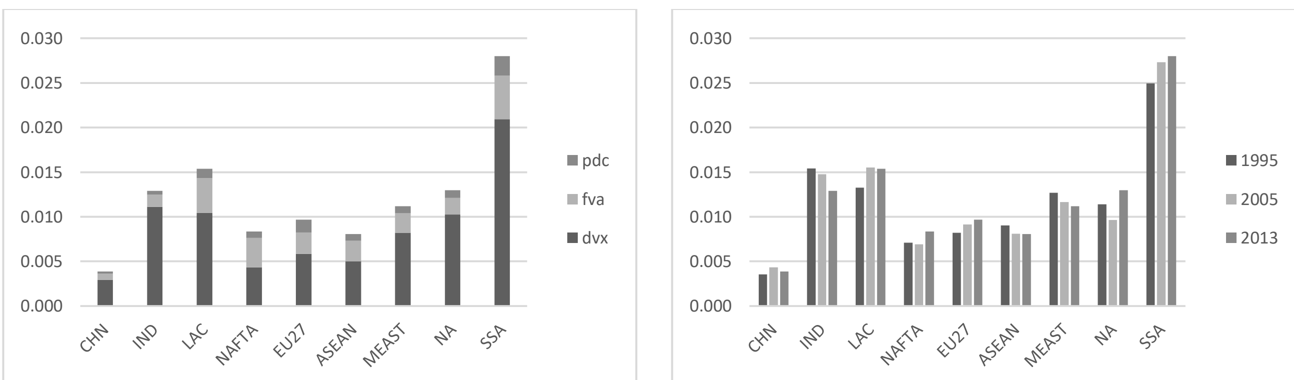
Figure 1. GVC participation index by world areas (all sectors)



1a: Components (2013) 1b: Trend

Notes: PDC stands for pure double counting, FVA foreign value added and DVX indirect value added. GVC participation = PDC + FVA + DVX. Source: Authors' elaboration on EORA data

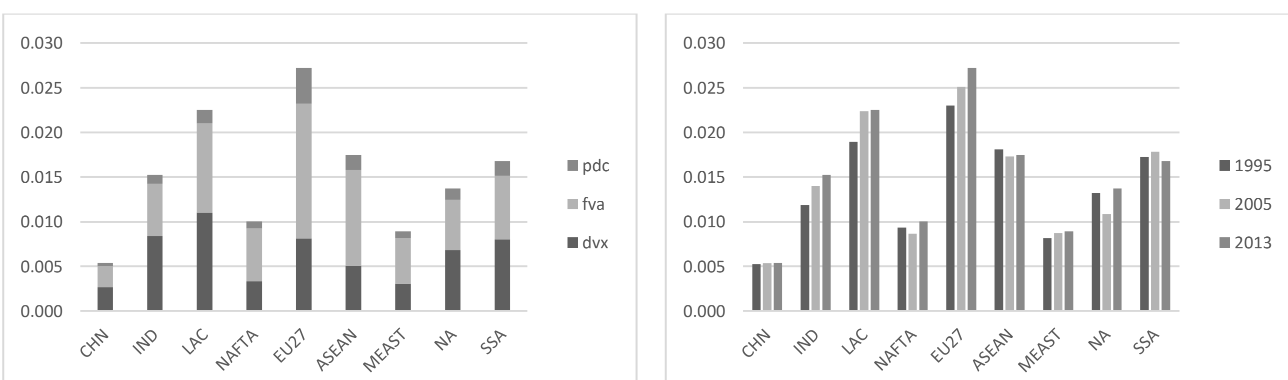
Figure 2. Agriculture GVC participation index by world areas



2a: Components (2013) 2b: Trend

Notes: PDC stands for pure double counting, FVA foreign value added and DVX indirect value added. GVC participation = PDC + FVA + DVX. Source: Authors' elaboration on EORA data

Figure 3. Food GVC participation index by world areas



3a: Components (2013) 3b: Trend

Notes: PDC stands for pure double counting, FVA foreign value added and DVX indirect value added. GVC participation = PDC + FVA + DVX. Source: Authors' elaboration on EORA data

Table 1. Baseline: agriculture and food GVCs components for All countries

			Agriculture					Food		
	(1a)	(2a)	(3a)	(4a)	(5a)	(1b)	(2b)	(3b)	(4b)	(5b)
Dep Var:	dirDVA	DVX	FVA	dirRDV	MVA	dirDVA	DVX	FVA	dirRDV	MVA
tariff rate (applied mean)_ji	-0.007***	-0.005***	-0.007***	-0.007***	-0.004**	-0.016***	-0.013***	-0.016***	-0.014***	-0.015***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
tariff rate (applied mean)_ij				-0.002	0.002				-0.012***	-0.007***
				(0.002)	(0.002)				(0.001)	(0.002)
RTA (yes=1)^	0.008	0.007	0.008	0.018***	-0.002	0.018***	0.019***	0.018***	0.029***	0.001
	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.005)	(0.006)	(0.006)	(0.007)
Observations	541,522	541,395	544,209	435,017	433,773	542,307	542,189	544,209	435,320	434,007
R-squared	0.995	0.995	0.995	0.997	0.997	0.996	0.996	0.996	0.998	0.998
Country pair fe	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Reporter*year fe	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Partner*year fe	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Country pair clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

^ three years lags from the entry into force of the agreement

Note: dirDVA stands for direct domestic value added, DVX indirect value added, FVA foreign value added, dirRDV domestic value added that returns home directly and MVA foreign value added sourced from the direct importer

Table 2. Baseline: agriculture and food GVCs components for SSA countries

			Agriculture					Food		
	(1a)	(2a)	(3a)	(4a)	(5a)	(1b)	(2b)	(3b)	(4b)	(5b)
Dep Var:	dirDVA	DVX	FVA	dirRDV	MVA	dirDVA	DVX	FVA	dirRDV	MVA
tariff rate (applied mean)_ji	-0.004	-0.004	-0.004	-0.004	-0.002	-0.021***	-0.017***	-0.021***	-0.017***	-0.019***
	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
tariff rate (applied mean)_ij				0.003	0.004				-0.008**	-0.001
				(0.005)	(0.006)				(0.003)	(0.004)
RTA (yes=1)^	0.007	0.013	0.007	0.055***	0.010	-0.035*	-0.024	-0.035*	0.024	-0.012
	(0.016)	(0.015)	(0.016)	(0.019)	(0.019)	(0.018)	(0.015)	(0.018)	(0.019)	(0.024)
Observations	126,533	126,506	126,533	99,624	98,626	126,533	126,503	126,533	99,632	98,672
R-squared	0.991	0.993	0.992	0.994	0.996	0.991	0.991	0.991	0.994	0.996
Country pair fe	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Reporter*year fe	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Partner*year fe	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Country pair clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

^ three years lags from the entry into force of the agreement

Note: dirDVA stands for direct domestic value added, DVX indirect value added, FVA foreign value added, dirRDV domestic value added that returns home directly and MVA foreign value added sourced from the direct importer

Table 3. Weighted tariffs: agriculture and food GVCs components for All countries

			Agriculture					Food		
	(1a)	(2a)	(3a)	(4a)	(5a)	(1b)	(2b)	(3b)	(4b)	(5b)
Dep Var:	dirDVA	DVX	FVA	dirRDV	MVA	dirDVA	DVX	FVA	dirRDV	MVA
tariff rate (applied weighted mean)_ji ^^	-0.009***	-0.008***	-0.009***	-0.008***	-0.007***	-0.016***	-0.014***	-0.016***	-0.015***	-0.016***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
tariff rate (applied weighted mean)_ij ^^				-0.003*	0.001				-0.012***	-0.009***
				(0.002)	(0.002)				(0.001)	(0.002)
RTA (yes=1)^	0.006	0.004	0.006	0.015**	-0.004	0.014**	0.014***	0.014**	0.024***	-0.002
	(0.006)	(0.006)	(0.006)	(0.007)	(0.008)	(0.006)	(0.005)	(0.006)	(0.006)	(0.007)
Observations	518,017	517,890	520,676	407,729	406,447	518,805	518,687	520,676	407,867	406,667
R-squared	0.995	0.995	0.995	0.997	0.998	0.996	0.996	0.996	0.998	0.998
Country pair fe	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Reporter*year fe	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Partner*year fe	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Country pair clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

^ three years lags from the entry into force of the agreement

^^ one year lag

Note: dirDVA stands for direct domestic value added, DVX indirect value added, FVA foreign value added, dirRDV domestic value added that returns home directly and MVA foreign value added sourced from the direct importer

Table 4. Weighted tariffs: agriculture and food GVCs components for SSA countries

	Agriculture					Food				
	(1a)	(2a)	(3a)	(4a)	(5a)	(1b)	(2b)	(3b)	(4b)	(5b)
Dep Var:	dirDVA	DVX	FVA	dirRDV	MVA	dirDVA	DVX	FVA	dirRDV	MVA
tariff rate (applied weighted mean)_ji ^^	-0.006*	-0.004	-0.006*	-0.003	-0.001	-0.019***	-0.016***	-0.019***	-0.015***	-0.018***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
tariff rate (applied weighted mean)_ij ^^				0.003	0.003				-0.008***	-0.005
				(0.004)	(0.005)				(0.003)	(0.004)
RTA (yes=1)^	0.006	0.011	0.006	0.058***	0.012	-0.039**	-0.027	-0.039**	0.024	-0.010
	(0.017)	(0.016)	(0.017)	(0.021)	(0.021)	(0.020)	(0.016)	(0.020)	(0.020)	(0.026)
Observations	121,069	121,042	121,069	92,528	91,601	121,069	121,039	121,069	92,536	91,647
R-squared	0.991	0.993	0.992	0.994	0.996	0.991	0.991	0.992	0.994	0.996
Country pair fe	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Reporter*year fe	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Partner*year fe	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Country pair clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

^ three years lags from the entry into force of the agreement

^^ one year lag

Note: dirDVA stands for direct domestic value added, DVX indirect value added, FVA foreign value added, dirRDV domestic value added that returns home directly and MVA foreign value added sourced from the direct importer

Appendix A: Tables and Figures

Table 1A. GVC participation by SSA countries in 2013

Country	DVX	FVA	PDC	GVC participation	*of which:* Agriculture	Food
Angola	0.26	0.04	0.02	**0.32**	0%	0%
Benin	0.15	0.09	0.02	**0.27**	11%	5%
Botswana	0.16	0.22	0.07	**0.44**	1%	10%
Burkina Faso	0.18	0.18	0.06	**0.41**	22%	3%
Burundi	0.26	0.13	0.05	**0.44**	15%	1%
Cameroon	0.33	0.05	0.03	**0.41**	15%	2%
Cape Verde	0.18	0.20	0.06	**0.44**	1%	3%
Central African Republic	0.36	0.08	0.04	**0.48**	11%	1%
Chad	0.24	0.04	0.02	**0.30**	28%	0%
Congo	0.28	0.06	0.03	**0.37**	3%	0%
DR Congo	0.46	0.06	0.06	**0.58**	4%	1%
Djibouti	0.21	0.13	0.05	**0.38**	5%	3%
Eritrea	0.24	0.08	0.03	**0.35**	4%	2%
Ethiopia	0.15	0.31	0.12	**0.58**	31%	5%
Gabon	0.27	0.04	0.02	**0.32**	15%	0%
Gambia	0.22	0.14	0.05	**0.41**	6%	9%
Ghana	0.31	0.06	0.03	**0.40**	34%	14%
Guinea	0.44	0.06	0.05	**0.55**	3%	1%
Ivory Coast	0.25	0.06	0.02	**0.33**	33%	15%
Kenya	0.19	0.17	0.04	**0.39**	30%	15%
Lesotho	0.11	0.36	0.10	**0.58**	0%	1%
Liberia	0.31	0.06	0.03	**0.40**	15%	0%
Madagascar	0.22	0.10	0.03	**0.35**	38%	8%
Malawi	0.21	0.10	0.03	**0.34**	39%	8%
Mali	0.19	0.08	0.02	**0.30**	23%	2%
Mauritania	0.23	0.13	0.05	**0.41**	1%	21%
Mauritius	0.13	0.31	0.06	**0.50**	1%	15%
Mozambique	0.23	0.07	0.03	**0.33**	22%	7%
Namibia	0.15	0.23	0.05	**0.44**	3%	28%
Niger	0.24	0.12	0.05	**0.40**	3%	1%
Nigeria	0.28	0.06	0.02	**0.36**	4%	1%
Rwanda	0.23	0.20	0.08	**0.51**	9%	1%
Sao Tome and Principe	0.20	0.21	0.08	**0.50**	7%	2%
Senegal	0.23	0.09	0.03	**0.34**	11%	42%
Seychelles	0.21	0.14	0.05	**0.40**	1%	36%
Sierra Leone	0.20	0.16	0.06	**0.42**	5%	5%
Somalia	0.21	0.08	0.03	**0.33**	10%	4%
South Africa	0.25	0.12	0.06	**0.43**	4%	2%
Swaziland	0.13	0.28	0.08	**0.49**	5%	16%
Tanzania	0.15	0.24	0.06	**0.45**	15%	13%
Togo	0.16	0.12	0.03	**0.31**	15%	7%
Uganda	0.19	0.11	0.03	**0.32**	32%	11%
Zambia	0.23	0.10	0.04	**0.37**	6%	2%

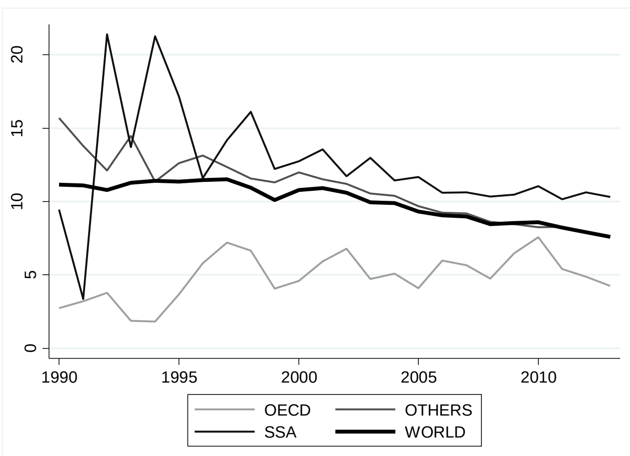
Note: PDC stands for pure double counting, FVA foreign value added and DVX indirect value added. GVC participation = PDC + FVA + DVX.

Table 2A. Variables applied in the empirical analysis: summary statistics

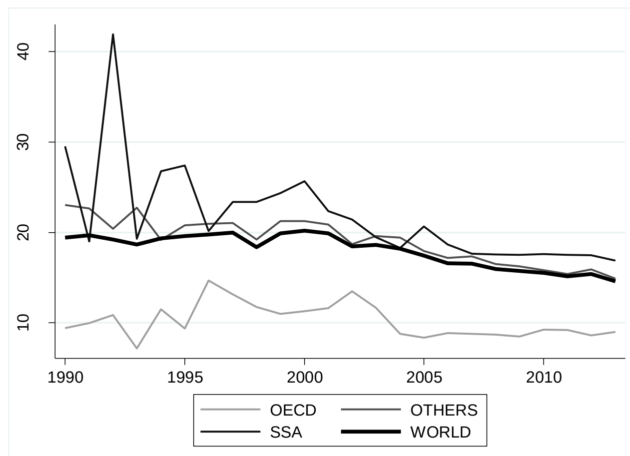
	Variables	Obs	Mean	Std. Dev.	Min	Max
	dirDVA	813,109	3.25	2.48	-5.16	16.33
	DVX	812,236	1.98	2.50	-7.19	14.99
	FVA	815,689	0.95	2.63	-6.48	14.72
Agriculture	dirRDV	811,535	-5.00	3.30	-19.38	13.68
	MVA	810,292	-6.26	3.79	-20.61	14.10
	tariff rate	563,408	1.80	1.09	0.00	6.62
	RTA (yes=1)	816,960	0.14	0.35	0.00	1.00
	dirDVA	813,852	3.46	2.80	-7.28	16.78
	DVX	810,820	-5.52	4.07	-19.98	14.76
	FVA	812,362	-4.99	3.47	-21.07	13.93
Food	dirRDV	815,694	1.88	2.92	-6.12	15.38
	MVA	813,118	1.96	2.54	-8.50	15.31
	tariff rate	563,408	2.45	1.23	0.00	8.01
	RTA (yes=1)	816,960	0.13	0.34	0.00	1.00

All variables are in logs.

Figure 1A. Average import tariff rates for Agriculture and Food, by area



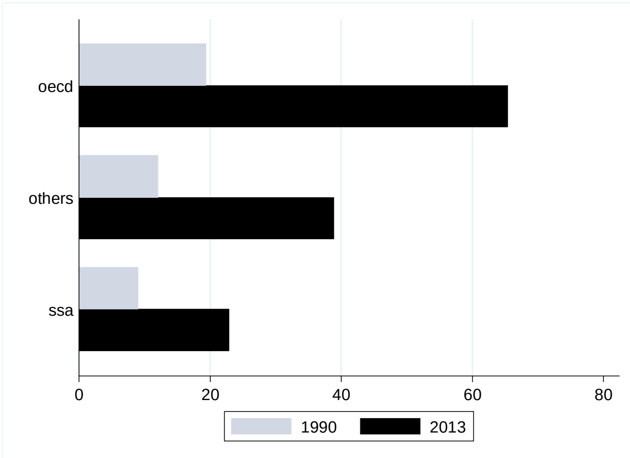
1Aa: Agriculture



1Ab: Food

Source: Authors' elaboration on WITS data

Figure 2A. Signed RTAs by area in 1990 and 2013



Source: Authors' elaboration on Egger and Larch (2008, updated to 2015) database

Footnotes

[i] The term GVC refers to the global networks of activities required to bring a product from its conception to end use and beyond (Gereffi and Fernandez-Stark, 2011).

[ii] The OECD shows that in 2010 the share of traded agricultural products not used for household consumption was 45%, based on the United Nations Broad Economic Classification (BEC) system (OECD, 2016).

[iii] Some of the terms in the PDC bucket double count value added originated in the home country, while other terms in the double count value added originated in foreign countries (WWZ, 2013).

[iv] The DVX component includes also the returned value added (RDV), that is the portion of domestic value added that is initially exported but ultimately returned home by being embedded in the imports from other countries and consumed at home.

[v] Since most of SSA countries lack information on national I-O tables, in order to get a balanced global MRIO, EORA uses interpolation and estimation to provide a contiguous, continuous dataset for the period 1990-2013. Therefore, we assume that our results are prudent estimates of the phenomena we analyze. In fact, we exclude from our analysis the recently born South Sudan (2011), Sudan, and Zimbabwe due to data inconsistency.

[vi] Since value added data comes from decomposition of national gross exports in value across countries it is, by construction, not possible to derive neither where the agriculture products are grown and harvested, nor where food products are actually produced.

[vii] Note that the reported measures tend to be inflated by intermediate flows between countries of the same region. This inserts a bias in favor of the EU27 relative to other single large countries or smaller regional groups (e.g., NAFTA).

[viii] The sum across all the sectors therefore equals the value of total GVC participation reported in Figure 1.

[ix] Europeans were interested in exploiting the capacity of African colonies to produce goods that could be consumed in the mother country. Hence, they forced or encouraged to orientate colonies' production towards tradable goods - mainly agricultural commodities and raw materials - that could be consumed and/or processed in Europe, or sold on international markets. Even after the decolonization process important segments of colonial populations remained involved and dependent in this kind of trade with Europe (Sokoloff and Engerman, 2000).

[x] In some cases, such as Uganda, Zambia and Niger, the EU absorbs almost 80% of the DVX despite the fact that the main destination for their gross exports is Africa.

[xi] In this case, there is also the so called “Rotterdam effect”, that refers to the fact that trade value with the Netherlands is artificially inflated by the goods dispatched from or arriving in Rotterdam even though the ultimate destination or country of origin differs.

[xii] Multilateral resistance has been theoretically demonstrated (Anderson and Van Wincoop, 2003) and empirically observed to bias the effects of bilateral protection on trade (Baldwin and Taglioni, 2006).

[xiii] These capture the effects of time-invariant bilateral trade costs (Piermartini and Yotov, 2016), including time-invariant reasons for signing trade agreements, and prevent possible “reverse causality” bias between trade flows and tariffs (Baier and Bergstrand, 2007). They also controls for self-selection bias due to the fact that countries that join RTAs are unlikely to be randomly chosen. Non-parametric alternatives to the standard gravity specification have also been proposed to account for the presence of nonlinearities in the relationship between FTAs, trade flows and the other covariates (Baier and Bergstrand, 2009; Montalbano and Nenci, 2014).

[xiv] WITS uses the concept of effectively applied tariff which is defined as the lowest available tariff. If a preferential tariff exists, it will be used as the effectively applied tariff. Otherwise, the MFN applied tariff will be used. The use of the applied tariffs controls directly for the actual utilization rates. Here, we use simple averages giving the same weight to all products (not imported as well as very large imports). This is because the level of nominal tariffs might influence the effective value of imports (e.g., a prohibitive tariff, wearing away imports, and tariff revenue could be interpreted as a zero-tariff rate). This problem is not such that it could affect the analysis at the aggregate level (and indeed most of the previous literature actually applies weighted averages). However, since tariffs in developing countries are higher than in industrialized countries and are very high in absolute terms, specifically in the case of SSA countries and for agriculture and food products, the use of weighted average tariffs could lead to incorrect interpretations. Furthermore, weighted tariffs could lead to simultaneity bias in the estimated coefficients. For the sake of comparison, in robustness checks, we also present the outcomes of weighted average where the imports value (in US dollars) of the reporter country are used as weights, showing that there are no meaningful differences between the two estimates.

[xv] RTAs are collected on the basis of the date the agreement entered into force and then lagged (t-n) to include the effects associated with implementation and phase-in. Data are sourced from Egger and Larch (2008) (for additional details, see also Grant and Lambert, 2008) and updated to 2015. Outcomes for alternative temporal lags for RTAs are available upon request.

[xvi] The effectively applied tariffs are weighted by the imports value (in US dollars) of the reporter country. We are aware that countries may be so locked into trade patterns that lagged values would not substantially differ from the current ones. Hence

we tested the same relationship by using alternative temporal lags for tariffs and the results are still consistent. These outcomes are available upon request.

[xvii] Further robustness checks are provided in the online Supplementary Appendix. Specifically, we compute: i) a Poisson maximum-likelihood estimator (PPML) approach to deal with econometric problems resulting from zero bilateral trade flows and heteroskedastic residuals in log-linear gravity equations (Silva and Tenreyro, 2006), and ii) an instrumental variable approach to possibly deal with the risk of reverse causality. Overall, results are similar to those presented in Section 3. In particular, the coefficients on our variables of interest, $tariff_{ji}$ and $tariff_{ij}$ are consistently negative in all the specifications for dirRDV, while as usual ambiguous for MVA.